REMARKS

Claim 1 has been amended for the purposes of clarification, but this amendment does not introduce new matter or new issues. In particular, "wherein the electrodes have at least one functionalized surface which is opposite to the resonator, wherein the functionalized surface is configured to react with target molecules" is changed to "wherein at least one of the electrodes has at least one functionalized surface that is configured to react with target molecules." This amendment has been made because there was no explicit antecedent basis for "the resonator" in claim 1, even though it was implicit that the term "resonator" referred to "FBAR." Also, "which FBAR is attached to the substrate at its edges" is changed to "wherein the FBAR is positioned with the edges on the substrate." This amendment has been made because the specification discloses on paragraph [0026] that the FBAR "is positioned with its edges on a … substrate ... ." The other changes in claim 1 are also minor, such as replacing "the resonator" to "the FBAR" and changing "the" at several occurrences to either "a" or "an." None of the changes made in claim 1 introduce a new limitation that was not previously considered by the Examiner.

The term "a" in the claims means "one or more." The Court of Appeals of the Federal Circuit has stated, "This court has repeatedly emphasized that an indefinite article 'a' or 'an' in patent parlance carries the meaning of 'one or more' in open-ended claims containing the transitional phrase 'comprising.' Unless the claim is specific as to the number of elements, the article 'a' receives a singular interpretation only in rare circumstances when the patentee evinces a clear intent to so limit the article." *KCJ Corp. v. Kinetic Concepts, Inc.*, 223 F.3d 1351, 1356 (Fed. Cir. 2000) (citations omitted).

Restriction Election Required

This application contains claims 25-30 drawn to an invention nonelected with traverse in the reply filed on 11/30/2005. The Action states that a complete reply to the final rejection must include cancellation of nonelected claims or other appropriate action (37 CFR 1.144) See MPEP § 821.01. Applicants have canceled claims 25-30.

Claim Rejections - 35 USC § 103

Claims 1, 4-13, 22 and 23 were rejected under 35 U.S.C. 103(a) as being unpatentable over Ward et al. (U.S. Patent No. 5,501,986 A) ("Ward") in view of Oyama et al. (U.S. Patent No. 5,552,274) ("Oyama") and Yamada et al. (U.S. Patent No. 6,842,088 B2) ("Yamada").

Claims 14-21 and 24 were rejected under 35 U.S.C. 103(a) as being unpatentable over the aforementioned cited prior art further in view of Blackburn et al. (U.S. Patent No. 6,846,654 B1) ("Blackburn").

Claim 31 was rejected under 35 U.S.C. 103(a) as being unpatentable over the aforementioned cited prior art further in view of Gao et al. (U.S. Patent No. 6,218,507 B1) ("Gao").

These rejections are respectfully traversed.

The Examiner relies on Ward for teaching a detection system having the following features: a quartz crystal wafer 12; a pair of electrodes 14 and 16; a coating layer 22 having a surface 18 that is functionalized with a specific bind reagent 32 to bind to target molecules 34; and control and detection circuitry having an oscillator circuit 30. The Examiner cites column 3, line 25 to column 6, line 20; column 5, lines 25-62; and Figures 1 and 3 of Ward.

Applicants respectfully submit that claim 1 clearly recites "a film bulk acoustic piezoelectric resonator (FBAR)." The biosensor of Ward in *not* a FBAR. The biosensor of Ward is a conventional electrochemical biosensor having quartz crystal microbalance and surface acoustic wave (SAW) resonator. This fact is quite clear from the specification of Ward itself. For example, in column 2, lines 6-7, Ward states, "Roederer et al. disclose an in-situ immunoassay using piezoelectric quartz crystals, specifically, *surface acoustic wave devices*." [Emphasis added.]

Then, Ward states the following in column 2, lines 39-48:

> As discussed by Roederer et al., piezoelectric crystal-based immunoassays in which mass change is attributable only to the

> immunological reaction between an antigen and an antibody can, under certain circumstances, suffer from poor sensitivity and poor detection limit. Consequently there is a need in the art for a piezoelectric crystal-based specific binding assay in which the reaction between a binding agent and its ligand can be amplified to provide a more sensitive and reliable assay. There is a further need for an assay without added procedural complexity.

Ward's invention solves the deficiencies of Roederer as explained in column 2, lines 52-66, which states:

> These needs are met by the present invention. In one aspect, a process is described for measuring the concentration of an analyte utilizing massive sol particles that have been modified to contain binding agents which make the particles capable of binding to the surface of a quartz crystal microbalance which also has been modified with a binding agent. The modified quartz crystal microbalance is referred to herein as a biologically modified quartz crystal microbalance, or BMQCM. The quartz crystal microbalance may have at least one of its surfaces modified by any combination of priming, coating or reagent layers. Binding of the sol reagent to the BMQCM results in a mass change at the surface of the BMQCM, which in turn produces a corresponding change in the resonant frequency of the quartz crystal.

Applicants respectfully submit that Ward modifies *a conventional SAW device* to arrive at a biologically modified quartz crystal microbalance, or BMQCM having at least one of its surfaces modified by any combination of priming, coating or reagent layers. Ward does *not* disclose a FBAR.

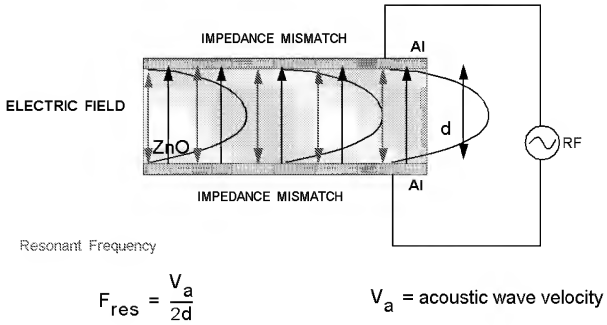
Ward issued from a U.S. application that is a continuation of Ser. No. 908,505, which is a continuation of Ser. No. 409,886, filed September 20, 1989. However, in 1989, in all likelihood, FBAR was not even invented as the first U.S. patent that mentions "film bulk acoustic resonator" is U.S. Patent No. 5,185,589, assigned to Westinghouse Electric Corp., which issued from an application filed on May 17, 1991. U.S. Patent No. 5,185,589 cites "Film Bulk Acoustic Resonator Technology, S. V. Krishnaswamy, J. Rosenbaum, S. Horwitz, C. Vale, R. A. Moore, Dec. 1990 IEEE Ultrasonics Symposium." Thus, it appears that the FBAR technology was developed in 1990

at Westinghouse, and that at the time of filing of the application that issued as the Ward patent, the FBAR technology had not even been developed.

FBAR is different from a conventional SAW device. For example, a website of University of Southern California at http://mems.usc.edu/fbar.htm explains FBAR as follows:

> Film Bulk Acoustic Resonator (FBAR) consists of a piezoelectric thin film sandwiched by two metal layers. A resonance condition occurs if the thickness of piezoelectric thin film (d) is equal to an integer multiple of a half of the wavelength (l_{res}). The fundamental resonant frequency ($F_{res}=1/l_{res}$) is then inversely proportional to the thickness of the piezoelectric material used, and is equal to $V_a/2d$ where V_a is an acoustic velocity at the resonant frequency (**Fig. 1**) [shown below, which shows a schematic of longitudinal wave generation and propagation in an film bulk acoustic resonator by an electric field in the thickness direction.]

In the FBAR of Fig. 1 below, the vibration of the piezoelectric thin film occurs in the bulk of the piezoelectric thin film in the thickness direction of the piezoelectric thin film as "[t]he acoustic wave [in FBAR] propagates in the same direction as the electric filed, and reflects at the interface between the electrode and the air." See Yamada, column 2, lines 5-8.



On the other hand, a SAW device is described in Wikipedia at http://en.wikipedia.org/wiki/Surface_acoustic_wave as follows:

> A surface acoustic wave (SAW) is an acoustic wave traveling along the surface of a material having some elasticity, with an amplitude that typically decays exponentially with the depth of the substrate. This kind of wave is commonly used in devices called SAW devices in electronics circuits. SAW devices are employed as filters, oscillators and transformers based on the transduction of acoustic waves. The transduction from electric energy to mechanical energy (in the form of SAWs) is accomplished by the use of piezoelectric materials.

In short, a FBAR device is totally different from a SAW device as the acoustic wave in FBAR travels in the thickness direction through the bulk of the piezoelectric material while the acoustic wave in SAW travels along the surface of a material. As the device disclosed in Ward is a SAW device, not a FBAR device, Applicants' respectfully submit that the Examiner's premise of what Ward teaches is incorrect.

Claim 1 also recites "a control circuitry comprising a signal generator configured to apply an excitation signal that includes a plurality of frequencies to the pair of electrodes and a processing circuitry to determine an impedance of the FBAR as a function of frequency, such that a mass, or an electrostatic charge or both, of the target molecules that have reacted with the functionalized surface causes a detectable change in a frequency response of the FBAR." The Examiner has acknowledged that Ward does not teach the incorporation of the control circuit as claimed, and thus relies on Oyama. However, Oyama also clearly states that "it contemplates a base sequence reading device, wherein the elastic wave element is a quartz oscillator (QCM) or a surface elastic wave element (SAW)" in column 4, lines 31-33. In short, both Ward and Oyama fail to teach or suggest "[a] device for detecting target molecules comprising … *a film bulk acoustic piezoelectric resonator (FBAR)*" of claim 1 *as a whole*.

Furthermore, as Ward's biosensor is a SAW device and Oyama's control circuitry is suitable for a QCM or SAW device, and persons of ordinary skill in the art would not modify Ward's biosensor or Oyama's control circuitry for a FBAR device as a QCM or SAW device operates by a totally different principle than that of a FBAR device. If the SAW biosensor of Ward or the QCM or SAW device of Oyama was to be modified into a FBAR biosensor, then the proposed modification of Ward or Oyama would change the principle of operation of Ward's or Oyama's invention from an acoustic wave traveling along the surface of a material to an acoustic wave traveling through the bulk of the material. As this modification would result in a change in the principle of operation, it would defeat a *prima facie* case of obviousness as explained in MPEP 2143.01:

> If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims *prima facie* obvious. *In re Ratti*, 270 F.2d 810, 123 USPQ 349 (CCPA 1959) (Claims were directed to an oil seal comprising a bore engaging portion with outwardly biased resilient spring fingers inserted in a resilient sealing member. The primary reference relied upon in a rejection based on a combination of references disclosed an oil seal wherein the bore engaging portion was reinforced by a cylindrical sheet metal casing. Patentee taught the device required rigidity for operation, whereas the claimed invention required resiliency. The court reversed the rejection holding the "suggested combination of references would require a substantial reconstruction and redesign of the elements shown in [the primary reference] as well as a change in the basic principle under which the [primary reference] construction was designed to operate." 270 F.2d at 813, 123 USPQ at 352.).

Applicants respectfully submit that prior to this invention, FBAR devices were not used as biosensors. As explained in paragraphs [0005] and [0006] of the specification, Applicants recognized that the prior art biosensors have several problems such as slow response and overestimation of the target substance concentration. The present inventors were the first to recognize that FBAR devices could be useful as biosensors and avoid the problems with convention biosensors such as those of Ward. Also, compared to a SAW resonator, FBAR provides higher

sensitivity and fast response time, a relatively simple structure, better power handling characteristics at high frequency, sharper resonance peak due to low parasiticies, larger surface area, and capability to retain its performance after surface functionalization and under/after wet process. All of these advantages of FBAR as applicable to biosensors were not known prior to this invention.

In view of the above amendment, applicant believes the pending application is in condition for allowance.

Dated: April 11, 2008

Respectfully submitted,

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